LabLink
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Colliding Ions at BNL

Superconducting magnets in the RHIC tunnel

At Brookhaven's Relativistic Heavy Ion Collider, or RHIC, more than 1,500 physicists from around the world study what the universe may have looked like in the first few moments after its creation. RHIC is a particle accelerator in which two beams of heavy ions (the nuclei of atoms like gold that have been stripped of electrons) whiz around in opposite directions at energies called "relativistic" because they approach the speed of light.

RHIC began colliding ions in the summer of 2000 with 1,740 superconducting magnets guiding the beams around the 2.4-mile underground tunnel. If the conditions are right, these collisions "melt" the protons and neutrons that make up the nuclei releasing for a brief instant, their constituent quarks and gluons. The energy of the collision creates thousands of new particles that stream out to RHIC's detectors. Each of these particles provides a clue as to what occurred inside the collision zone.

What scientists learn from RHIC helps us understand more about why the physical world works the way it does. The information can be applied in nuclear, particle, and condensed matter physics, as well as in the study of stars, planets, and our universe.

Happenings

- **November 30 –** Noon recital, The Horszowski Trio – Jesse Mills, violinist, Raman Ramakrishnan, cellist, and pianist Rieko Aizawa will perform works from Beethoven's "Ghost Trio," and the "Trio in F minor by Dvorak," Berkner Hall Auditorium.
- **December 8 –** Community Advisory Council meeting, 7 p.m., Berkner Hall, Room B.
- **December 14 –** Essayist David Bouchier will read from his latest book titled "Peripheral Vision: Irregular Essays from Public Radio," and will talk about the special pleasures of the personal essay. Noon, Berkner Hall.
- **December 15 –** Dava Sobel, award-winning author and former science reporter for the NY Times, will give a talk titled "A More Perfect Heaven: How Copernicus Revolutionized the Cosmos," 7 p.m., Berkner Hall Auditorium.
- **January 14 –** Noon recital, Berkner Hall Auditorium.

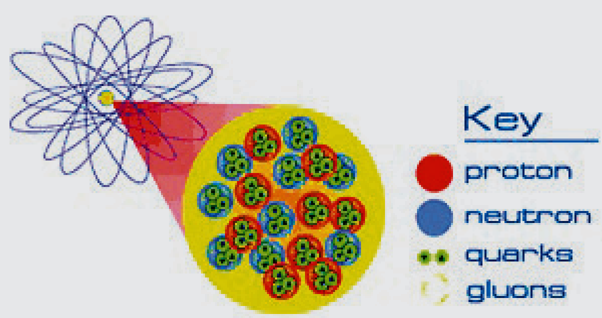
*The events above are free and open to the public. Visitors 16 and over must bring a photo ID for access to BNL events.

RHIC –Stepping Back in Time

To understand why RHIC collisions are scientifically interesting it is important to know that all protons and neutrons, found in the nucleus of the atom, are made up of three quarks, along with the gluons that bind them.

Theory holds that for a brief time at the beginning of the universe there were no protons and neutrons, only free quarks and gluons. However, as the universe expanded and cooled, the quarks and gluons bound together and, for the next 13 billion years, remained virtually inseparable. RHIC is the first instrument built that takes us "back in time" to see how matter behaved at the start of the universe.

What researchers have discovered from the RHIC collisions was surprising -- the new state of hot, dense matter created out of the quarks and gluons was quite different than what had been predicted. Instead of behaving like a gas of free quarks and gluons, the matter appeared to be more like a "perfect" liquid with no resistance to flow. Scientists are now working to get a detailed understanding of the "quark-gluon plasma" produced at RHIC.



Exploring the Mysteries of Spin

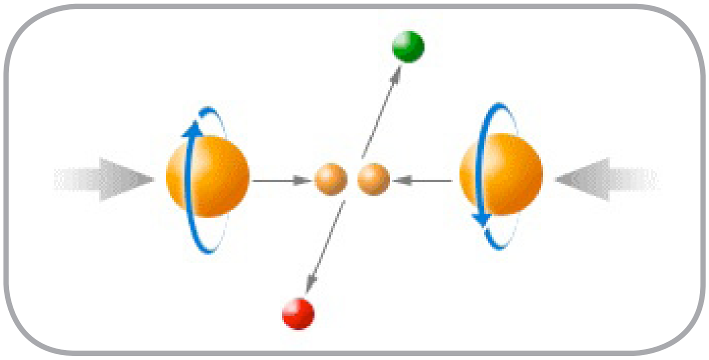


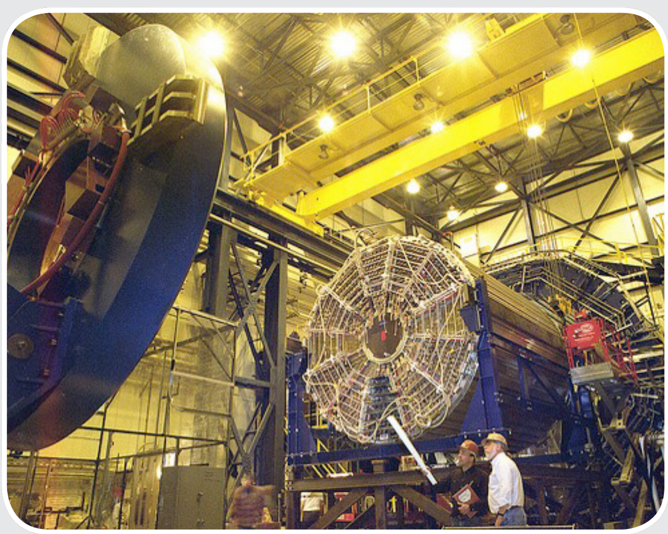
Illustration of a proton-proton collision.

At RHIC, scientists are also hoping to unravel the mystery of proton spin. Spin, a quantum property that describes a particles' intrinsic angular momentum, is part of a particle's identity like charge and mass. But unlike charge and mass, spin has a direction that can be oriented differently for individual particles of a given species. The interactions among particles inside atoms, nuclei, and protons depend on their relative spin orientations, with influence on a wide range of electrical, magnetic, optical, and other properties of matter. Yet, despite the fact that proton spin is used in everyday applications like magnetic resonance imaging (MRI), exactly how, and how much the individual particles that make up protons, contribute to spin remains a mystery.

Scientists know that the quarks inside a proton each have their own intrinsic spin. But numerous experiment's have confirmed that a directional preference among all these quark spins can account for only about 25 percent of the proton's total spin. Scientists at RHIC are trying to discover other factors that account for the total spin. New detection techniques and the ability to collide polarized (i.e. spin-aligned) proton beams at very high energies at RHIC will allow for directly probing the polarization contributions from different types of quarks inside protons as well as from the gluons, which carry the forces binding the quarks together and also have intrinsic spins. Extending RHIC's world-record energies for the accelerations of proton beams should move scientists closer to a quantitative understanding of proton spin and dynamics.

Advancing Scientific Discoveries

The U.S. Department of Energy (DOE) and the Indian Department of Atomic Energy (DAE) have reached an agreement that builds on a long-history of successful scientific collaborations between the two Departments. The latest step in deepening cooperation between the U.S. and India on a range of clean energy and scientific fronts, the agreement provides a legal framework to expand upon ongoing collaborations and launch new joint projects in high energy physics and nuclear physics for discovery science and technological innovation. Under the agreement, research collaborations in superconducting radiofrequency accelerator technology, heavy ion physics, and particle detector development at Brookhaven National Laboratory and other DOE labs, will be expanded.



The Solenoidal Tracker at RHIC (STAR) is a detector which specializes in tracking the thousands of particles produced by each ion collision at RHIC.

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